

# XL-MaxSonar® - WR/WRC™ Series

High Performance, IP67 Weather Resistant, Ultrasonic Range Finder

MB7051, MB7052, MB7060, MB7062, MB7066, MB7067, MB7068,  
MB7070, MB7072, MB7076, MB7077, MB7078, MB7092<sup>3</sup>

The XL-MaxSonar-WR and XL-MaxSonar-WRC sensor series provide users with robust range information in air. These sensors also feature high-power acoustic output along with real-time auto calibration for changing conditions (supply voltage sag, acoustic noise, or electrical noise), operation with supply voltage from 3V to 5.5V, object detection from 0-cm to 765-cm (select models) or 1068-cm (select models), and sonar range information from 20-cm<sup>1</sup> out to 765-cm (select models) or 1068-cm (select models) with 1-cm resolution. Objects from 0-cm to 20-cm<sup>1</sup> range as 20-cm<sup>1</sup> or closer. The sensor is housed in a robust PVC housing, designed to meet the IP67 water intrusion standard, and matches standard electrical/water 3/4" PVC pipe fittings. The user interface formats included are pulse-width (select models), real-time analog-voltage envelope (select models), analog voltage output, and serial output.

<sup>1</sup> 25cm (MB7052, MB7092 Pipe and Compact, also including MB7051 horned part)



## Features

- Real-time auto calibration and noise rejection
- High acoustic power output
- Precise narrow beam
- Object detection includes zero range objects
- 3V to 5.5V supply with very low average current draw
- Free run operation can continually measure and output range information
- 10Hz refresh rate (MB7060, MB7062, MB7066, MB7070, MB7072, MB7076, MB7092)
- 6.6Hz refresh rate (MB7052)
- 5.1Hz refresh rate (MB7051)
- Triggered operation provides the range reading as desired
- All interfaces are active simultaneously
- RS232 Serial, 0 to Vcc, 9600 Baud, 81N

- Analog, (Vcc/1024) / cm for standard models
- Analog, (Vcc/1024) / 2cm for 10-meter models (MB7051, MB7066, MB7076)
- Sensor operates at 42KHz

## Benefits

- Acoustic and electrical noise resistance
- Reliable and stable range data
- Robust, low cost IP67 standard sensor
- Narrow beam characteristics
- Very low power excellent for battery based systems
- Ranging can be triggered externally or internally
- Sensor reports the range reading directly, frees up user processor
- Easy hole mounting or mating with standard electrical fittings
- Filtering allows very reliable operation in most environments

## Applications and Uses

- Tank level measurement
- Bin level measurement
- Proximity zone detection
- Environments with acoustic and electrical noise
- Distance measuring
- Long range object detection
- Super high sensitivity for long range small object detection (MB7051)
- Industrial sensor -40°C to +65°C (limited operation to +85°C)<sup>2</sup>

### Notes:

- <sup>1</sup> Minimum distance is 25cm for the MB7052, MB7092 Pipe and Compact, also including MB7051 horned part.  
<sup>2</sup> Please reference page 14 for minimum operating voltage verses temperature information  
<sup>3</sup> Please reference page 23 for part number key

## Close Range Operation

Applications requiring 100% reading-to-reading reliability should not use MaxSonar sensors at a distance closer than 20cm<sup>1</sup>. Although most users find MaxSonar sensors to work reliably from 0 to 20cm<sup>1</sup> for detecting objects in many applications, MaxBotix® Inc. does not guarantee operational reliability for objects closer than the minimum reported distance. Because of ultrasonic physics, these sensors are unable to achieve 100% reliability at close distances.

<sup>1</sup> 25cm (MB7052, MB7092 Pipe and Compact, also including MB7051 horned part)

## Warning: Personal Safety Applications

We do not recommend or endorse this product be used as a component in any personal safety applications. This product is not designed, intended or authorized for such use. These sensors and controls do not include the self-checking redundant circuitry needed for such use. Such unauthorized use may create a failure of the MaxBotix® Inc. product which may result in personal injury or death. MaxBotix® Inc. will not be held liable for unauthorized use of this component.

## XL-MaxSonar-WR/WRC Pin Out

**Pin 1-** Leave open (or high) for serial output on the Pin 5 output. When Pin 1 is held low the Pin 5 output sends a pulse (instead of serial data), suitable for low noise chaining.

**Pin 2-** This pin outputs a pulse-width representation of range. To calculate the distance, use a scale factor of 58uS per cm. (MB7051, MB7052, MB7060, MB7062, MB7066, MB7067, MB7068)

This pin outputs the analog voltage envelope of the acoustic waveform. For the MB7070 series and MB7092 sensors, this is a real-time always-active output (MB7070, MB7072, MB7076, MB7077, MB7078, MB7092)

**Pin 3- AN-** This pin outputs analog voltage with a scaling factor of  $(V_{cc}/1024)$  per cm. A supply of 5V yields  $\sim 4.9\text{mV/cm}$ , and 3.3V yields  $\sim 3.2\text{mV/cm}$ . Hardware limits the maximum reported range on this output to  $\sim 700$  cm at 5V and  $\sim 600$  cm at 3.3V. The output is buffered and corresponds to the most recent range data.

For the 10-meter sensors (MB7051, MB7066, MB7076) Pin 3 outputs an analog voltage with a scaling of  $(V_{cc}/1024)$  per 2cm. A supply of 5V yields  $\sim 4.9\text{mV}/2\text{cm}$ , and 3.3V yields  $\sim 3.2\text{mV}/2\text{cm}$ . This Analog Voltage output steps in 2cm increments.

**Pin 4- RX-** This pin is internally pulled high. If Pin-4 is left unconnected or held high, the sensor will continually measure the range. If Pin-4 is held low the sensor will stop ranging. Bring high 20uS or more to command a range reading.

**Pin 5- TX-** When Pin 1 is open or held high, the Pin 5 output delivers asynchronous serial data in an RS232 format, except the voltages are 0-Vcc. The output is an ASCII capital "R", followed by ASCII character digits representing the range in centimeters up to a maximum of 765 (select models) or 1068 (select models), followed by a carriage return (ASCII 13). The baud rate is 9600, 8 bits, no parity, with one stop bit. Although the voltages of 0V to Vcc are outside the RS232 standard, most RS232 devices have sufficient margin to read the 0V to Vcc serial data. If standard voltage level RS232 is desired, invert, and connect an RS232 converter such as a MAX232. When Pin 1 is held low, the Pin 5 output sends a single pulse, suitable for low noise chaining (no serial data).

**V+** Operates on 3V - 5.5V. The average (and peak) current draw for 3.3V operation is 2.1mA (50mA peak) and 5V operation is 3.4mA (100mA peak) respectively. Peak current is used during sonar pulse transmit. Please reference page 14 for minimum operating voltage verses temperature information.

**GND-** Return for the DC power supply. GND (& V+) must be ripple and noise free for best operation.

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## About Ultrasonic Sensors

Our ultrasonic sensors are desired for use in air, non-contact object detection and ranging sensors that detect objects within a defined area. These sensors are not affected by the color or other visual characteristics of the detected object. Ultrasonic sensors use high frequency sound to detect and localize objects in a variety of environments. Ultrasonic sensors measure the time of flight for sound that has been transmitted to and reflected back from nearby objects. Based upon the time of flight, the sensor then outputs a range reading.

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## Auto Calibration

Each time before the XL-MaxSonar-WR takes a range reading it auto calibrates. The sensor then uses this data to range objects. If the temperature, humidity, or applied voltage changes during sensor operation, the sensor will continue to function normally. (The sensors do not apply compensation for the speed of sound change verses temperature to any range readings.) If the application requires temperature compensation please look at the HRXL-MaxSonar-WR sensor line.

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## Supply Voltage Compensation

During power up, the XL-MaxSonar-WR sensor line will calibrate itself for the supply voltage. Additionally, the sensor will compensate if the supplied voltage gradually changes.

If the average voltage applied to the sensor changes faster than 0.5V per second, it is best to remove and reapply power to the sensor. For best operation, the sensor requires noise free power. If the sensor is used with noise on the supplied power or ground, the accuracy of the readings may be affected. Typically, adding a 100uF capacitor at the sensor between the V+ and GND pins will correct most power related electrical noise issues.

## Real-time Auto Calibration

The XL-MaxSonar-WR automatically calibrates prior to each range reading. The sensor then uses this data to range objects. If the temperature, humidity, or applied voltage changes during sensor operation, the sensor will continue to function normally. (The sensors do not apply compensation for the speed of sound change verses temperature to any range readings.) Detection has been characterized in the published sensor beam patterns.

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## Real-time Noise Rejection

While the XL-MaxSonar-WR is designed to operate in the presence of noise, best operation is obtained when noise strength is low and desired signal strength is high. Hence, the user is encouraged to mount the sensor in such a way that minimizes outside acoustic noise pickup. In addition, keep the DC power to the sensor free of noise. This will let the sensor deal with noise issues outside of the users direct control (Even so, in general, the sensor will still function well even if these things are ignored). Users are encouraged to test the sensor in their application to verify usability.

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## Sensor Minimum Distance

The XL-MaxSonar-WR sensors have a minimum reported distance of 20-cm<sup>1</sup> (7.87 inches). However, the XL-MaxSonar-WR will range and report targets to the front sensor face. Large targets closer than 20-cm<sup>1</sup> will typically range as 20-cm<sup>1</sup>. For the alternative housings, objects between 4-cm and 20-cm will typically range as 20-cm.

*Note 1: 25cm for the MB7052, MB7092 Pipe and Compact, also including MB7051 horned part.*

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## WR Exposed Materials

The exposed materials of a properly mounted MaxSonar WR standard sensor are: Aluminum (oxidized surface), PVC, & silicone rubber (VMQ).

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## Additional Options for Purchase

Please contact MaxBotix for any additional information regarding the options listed below at [info@maxbotix.com](mailto:info@maxbotix.com).

### F-Option

In addition to the standard MaxSonar WR, MaxBotix Inc. has developed the F-Option for additional protection necessary in a few hazardous chemical environments. Extremely corrosive gases or liquids can degrade or compromise the operation of the sensing unit. As a result, we offer a more chemically inert seal which allows our sensors to operate in all but the harshest of chemical environments. In addition to the chemical resistance the sensor has improved performance in wet or dust environments.

Please Note: Our sensors are designed for operation in normal atmosphere (air). Please be aware that the speed of sound and atmospheric attenuation may change as a result of the transmission properties of different chemical/air mediums. Users are strongly encouraged to characterize and test the operation of the sensor in the new medium to verify operation, and properly scale the outputted range information.

The exposed materials of a properly mounted MaxSonar WR sensor with the F-Option added are: Aluminum (oxidized surface), PVC, & Fluorosilicone (with an additional back up FEP Teflon® seal).

### Shielded Cable Attach Option

For simple integration of our sensors into end-user applications, MaxBotix has developed the Shielded Cable Attach Option to create a completely IP67 rated MaxSonar-WR sensor. The standard Shielded Cable Attach Option uses 3 feet of the MaxSonar MB7954 Shielded Cable (MB7984 when attached by MaxBotix) with an epoxy filled cap to fully protect the pin-out of the MaxSonar sensor. Additional cable length can be specified and purchased using part number MB7984.

### P-Option

The P-Option is a Parylene coating applied to the surface of the aluminum transducer. This helps to improve the corrosion resistance of the aluminum transducer. The exposed materials of a properly mounted MaxSonar WR sensor with the P-Option added are: Parylene, PVC, & silicone rubber (VMQ). The F-Option can be purchased with the P-Option.

## Sensor Descriptions

### Base Sensor (MB7060 and MB7070)

The MB7060 and MB7070 are the base models of the XL-MaxSonar-WR sensor line. These sensors are recommended for general purpose usage. All other sensors in this series are based off these sensor models. The additional features are mentioned in their respective sections below.

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### XL-MaxSonar-WR1 (MB7062 and MB7072)

The XL-MaxSonar-WR1 sensors feature a 3 reading stability filter that ranges to the first detectable target. Filtering is available on Pin3 (AN) and Pin 5 (TX). Filtering is not applied to the output on Pin 2 (PW). This filter requires that 3 consecutive range readings are within 1cm of each other to be considered a valid range reading. If the range readings are outside 1cm, the sensor discards the range reading set and reports the last valid range reading. This sensor does not view maximum range as a valid range, and will not report 765 when no target is detected. If this sensor does not detect a target for 1 hour, the sensor will go into fail-safe and report 000.

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### XL-MaxSonar-WRL (MB7066 and MB7076)

The XL-MaxSonar-WRL will report a maximum distance of 10 meters for large targets.

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### XL-MaxSonar-WRM (MB7052 and MB7092)

The MB7052 and MB7092 sensors prioritize large targets over both small targets and noise. These sensors report the target that gives the largest acoustic reflection. This stands in contrast to other units such as the MB7060 which are designed to report the distance to the first detectable target. If the largest target is removed from the field of view, the MB7052 and MB7092 will switch to the target that gives the next largest detectable return.

When targets are of similar amplitude reflections, preference is given to the closer target. The sensor expects to see a target by 7.56 meters. If no target is found, the sensor will increase in sensitivity until a target is found, or until no targets can be found.

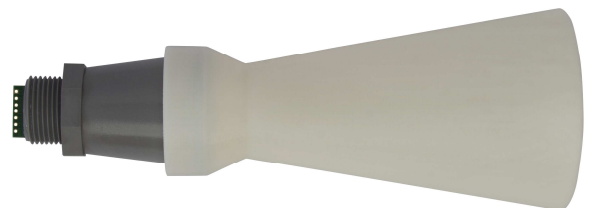
In addition to the most-likely filtering, the MB7052 and MB7092 come equipped with a three-reading filter and reading hold which requires three consecutive range readings within 1cm of the most recent reading to be considered a valid range reading. If readings are found to be outside 1cm, or no target can be found by the sensor, then the sensor will report the last valid range reading. Upon power-up the sensor will default to reporting 7.65 meters unit a valid range reading is found.

The last reading hold is designed for users operating in environments with intermittent high noise who desire to poll the MB7052 or MB7092 at intermittent times. This allows the sensor to report the previously valid reading until the sensor's environment improves. If no valid range reading is found for ~1.5 hours, the sensor will send a fail-safe output "000" on all interfaces.

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### XL-MaxSonar-WRML (MB7051)

The MB7051 includes all the features of the MB7052 with a maximum distance of 10 meters which provides a very robust long range sensing solution. The MB7051 is ideal for applications requiring small or soft target detection at longer ranges than our previously mentioned XL-MaxSonar-WR sensors.



The MB7051 has improved sensitivity to objects with the addition of a horn extension. This improvement results in the sensor detecting objects of similar size about 2.5 times further in comparison to the MB7066 sensor. The detection patterns of each are shown in the beam pattern section of the datasheet.

## Sensor Comparison Chart

Part Number	AN Voltage	Serial Data (0 to Vcc level)	Pulse Width	Analog Envelope	Stability Filter	Most Likely Filter	Refresh Rate	Other Packages Available <sup>1</sup>	7 meter range	10 meter range
MB7051	Yes	RS232	Yes		Yes	Yes	5.1Hz			Yes
MB7052	Yes	RS232	Yes		Yes	Yes	6.6Hz	Yes	Yes	
MB7060	Yes	RS232	Yes				10Hz	Yes	Yes	
MB7062	Yes	RS232	Yes		Yes		10Hz	Yes	Yes	
MB7066	Yes	RS232	Yes				10Hz			Yes
MB7070	Yes	RS232		Yes			10Hz	Yes	Yes	
MB7072	Yes	RS232		Yes	Yes		10Hz	Yes	Yes	
MB7076	Yes	RS232		Yes			10Hz			Yes
MB7092	Yes	RS232		Yes	Yes	Yes	10Hz	Yes	Yes	

Notes: 1 Alternative package types have a maximum effective detection range of 645cm, the sensor will still report 765 as a “no detection” output if a target is not found

## About Package Types

The XL-MaxSonar-WR sensor line is available in a variety of packages for applications with specific mounting

Package Types Currently Available
Full Horn — 3/4" NPT straight; back mounted thread (best performance)
Compact — 3/4" NPT straight; back mounted thread
Ultra-Compact — PCB with 4 mounting holes
1"NPS — External thread over full sensor body (1"NPS)
1" BSPP — External thread over full sensor body (1"BSPP)
30mm1.5 — External thread over full sensor body (30mm1.5)
MB7051— Full Horn with a horn extension (Not pictured)
<b>All package types have exposed PCB on user end for easy connection. Users desiring a fully enclosed assembly may purchase the “Shielded Cable Option” along with their sensor.</b>



requirements. The full horn package provides peak accuracy and sensitivity in this sensor line. It is recommended that testing is completed to ensure that the selected sensor will operate as desired in your application.

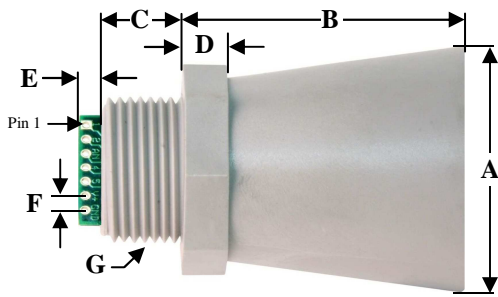
## Performance Changes when Selecting a Non-Full Horn Package

When selecting a XL-MaxSonar-WR without the full horn the sensor will experience the following performance changes:

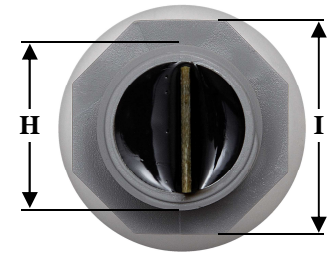
- The sensor will have a wider beam shape for the first meter.
- The sensor may have a dead zone from 0-6cm.
- The sensor may be less accurate by an additional +/- 0.5%.
- The sensor may have worse performance to small or soft targets.
- The sensor may experience decreased noise immunity when ranging to small, soft, angled, or distant targets.
- The maximum effective detection range is to 645cm, the sensor will still report 765 as a “no detection” output if a target is not found.

## Mechanical Dimensions

### Full Horn

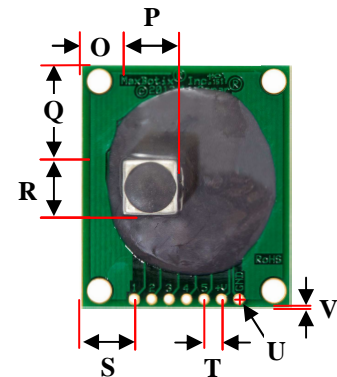
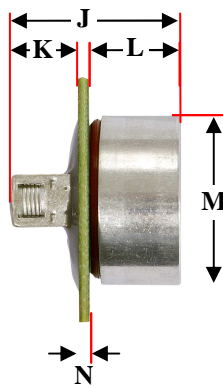
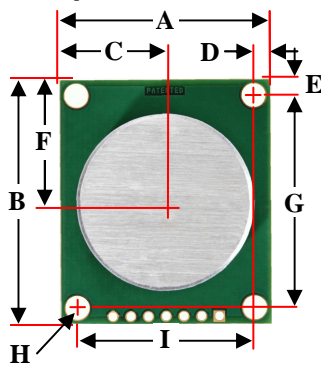


A	1.72" dia.	43.8 mm dia.
B	2.00"	50.7 mm
C	0.58"	14.4 mm
D	0.31"	7.9 mm
E	0.23"	5.8 mm
F	0.10"	2.54 mm
G	3/4"-14 NPS	
H	1.032" dia.	26.2 mm dia.
I	1.37"	34.8 mm
Weight		50 grams



Values Are Nominal

### Ultra-Compact



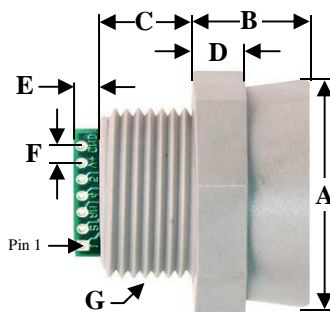
All values are nominal		
A	30.48 mm	1.20"
B	35.56 mm	1.40"
C	12.24 mm	0.60"
D	2.54 mm	0.10"
E	2.54 mm	0.10"

F	17.78 mm	0.70"
G	30.48 mm	1.20"
H	3.18 mm	0.13"
I	25.4 mm	1.00"
J	25.27 mm	1.00"
K	10.4 mm	0.41"

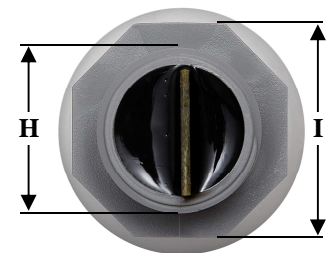
L	13.4 mm	0.53"
M	25.0 mm	0.98"
N	1.57 mm	0.062"
O	6.2 mm	0.24"
P	8.0 mm	0.31"
Q	13.9 mm	0.55"

R	7.80 mm	0.31"
S	7.62 mm	0.30"
T	2.54 mm	0.10"
U	1.07 mm	0.04"
V	1.27 mm	0.05"
Weight 15.1 gram.		

### Compact Housing



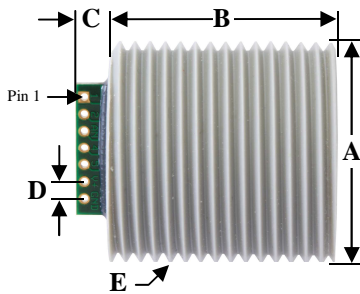
A	1.37" dia.	34.7 mm dia.
B	0.70"	17.9 mm
C	0.57"	14.4 mm
D	0.31"	7.9 mm
E	0.23"	5.8 mm
F	0.10"	2.54 mm
G	3/4"-14 NPS	
H	1.032" dia.	26.2 mm dia.
I	1.37"	34.8 mm
Weight		32 grams



Values Are Nominal

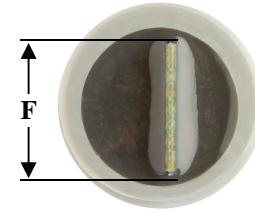
## Mechanical Dimensions Continued

### 1" NPS Pipe Threading

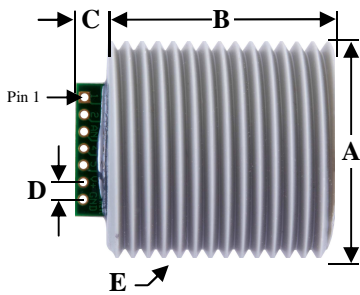


<b>A</b>	1.29" dia.	38.2 mm dia.
<b>B</b>	1.30"	33.1 mm
<b>C</b>	0.20"	5.2 mm
<b>D</b>	0.10"	2.54 mm
<b>E</b>	1"— NPS	
<b>F</b>	0.78"	19.8 mm
<b>Weight</b>		35 grams

Values Are Nominal

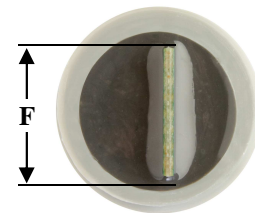


### 1" BSPP Pipe Threading

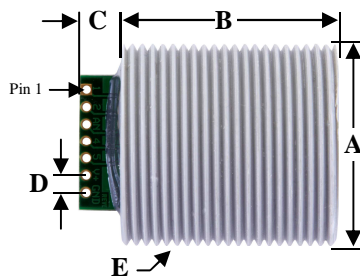


<b>A</b>	1.29" dia.	38.2 mm dia.
<b>B</b>	1.30"	33.1 mm
<b>C</b>	0.20"	5.2 mm
<b>D</b>	0.10"	2.54 mm
<b>E</b>	1"— BSPP	
<b>F</b>	0.78"	19.8 mm
<b>Weight</b>		34 grams

Values Are Nominal

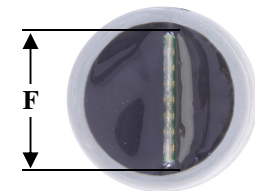


### 30mm1.5 Pipe Threading

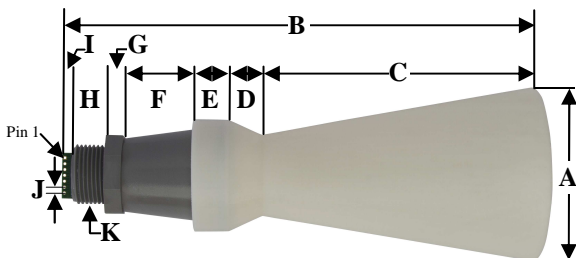


<b>A</b>	1.17" dia.	29.7 mm dia.
<b>B</b>	1.30"	33.1 mm
<b>C</b>	0.20"	5.2 mm
<b>D</b>	0.10"	2.54 mm
<b>E</b>	30mm 1.5	
<b>F</b>	0.78"	19.8 mm
<b>Weight</b>		31 grams

Values Are Nominal



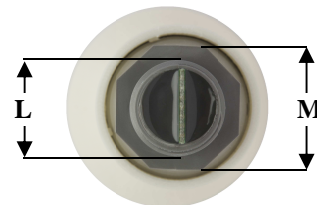
### MB7051



<b>A</b>	3.039" dia.	77.2 mm dia.
<b>B</b>	8.327"	211.5mm
<b>C</b>	4.827"	122.6mm
<b>D</b>	0.636"	16.2mm
<b>E</b>	0.580"	14.7mm

<b>F</b>	1.198"	30.4mm
<b>G</b>	0.315"	7.9mm
<b>H</b>	0.580"	14.7mm
<b>I</b>	0.191"	4.9mm
<b>J</b>	0.10"	2.54 mm

Values Are Nominal

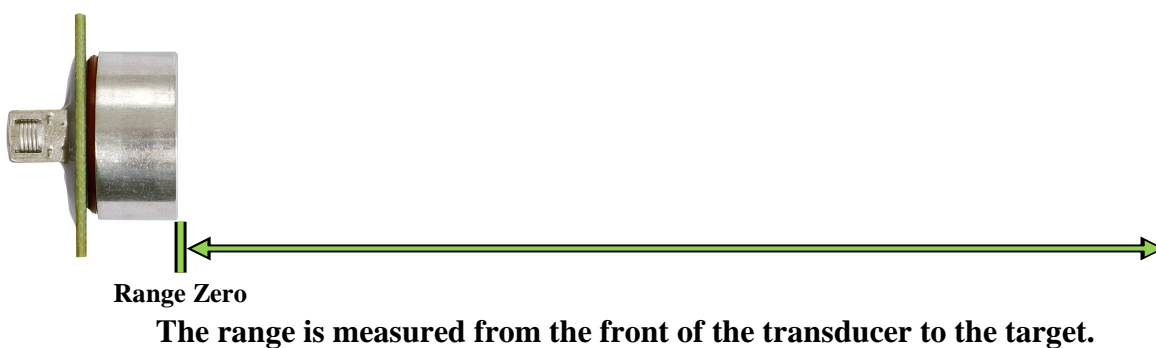
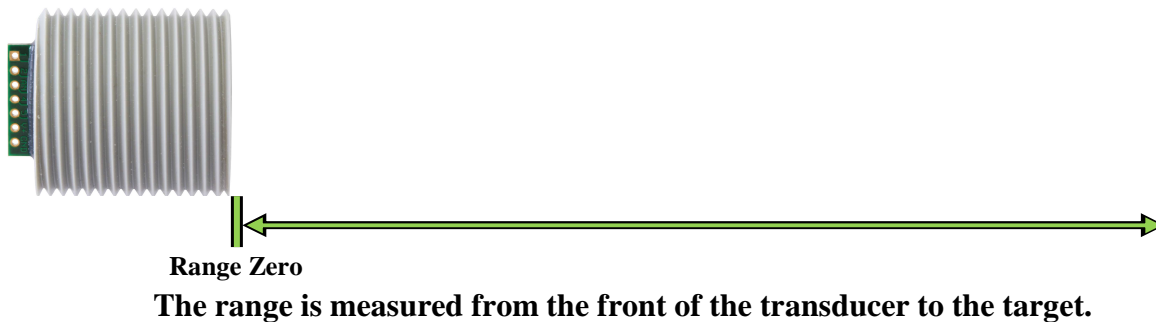
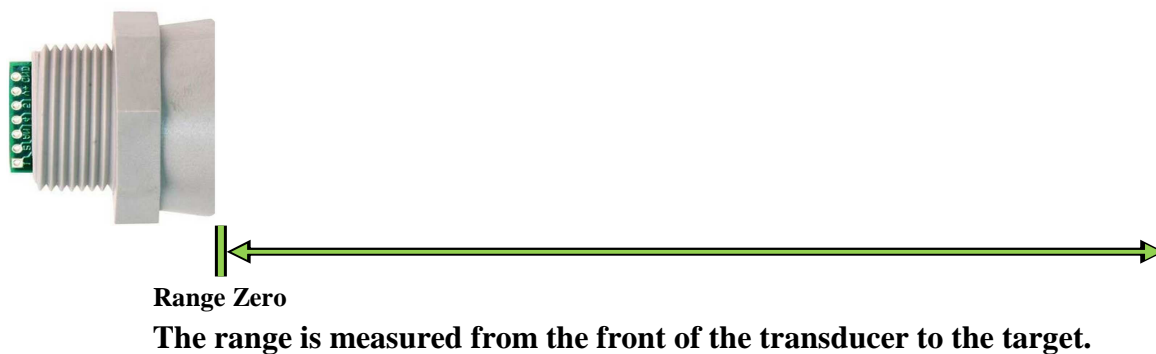


<b>K</b>	3/4"-14 NPS	
<b>L</b>	1.032" dia.	26.2 mm dia.
<b>M</b>	1.37"	34.8 mm
<b>Weight</b>		50 grams

## Range "0" Location

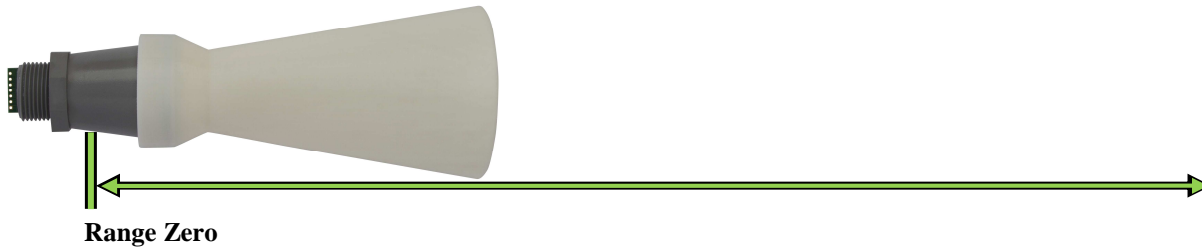
The XL-MaxSonar-WR sensors reports the range to distant targets starting from the front of the sensor as shown in the diagrams below.

The XL-MaxSonar-WR will report the range to the closest detectable object. Target detection has been characterized in the sensor beam patterns.





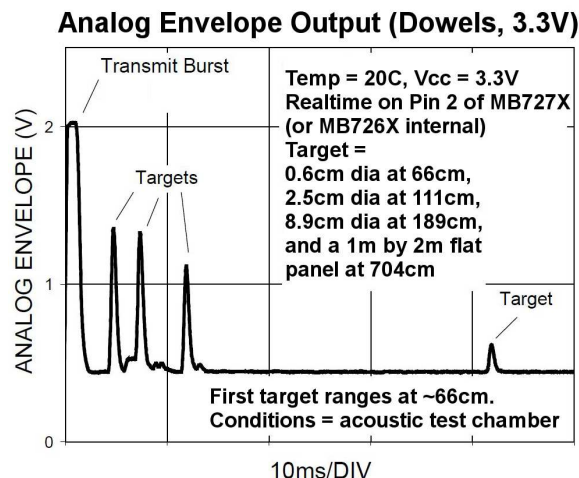
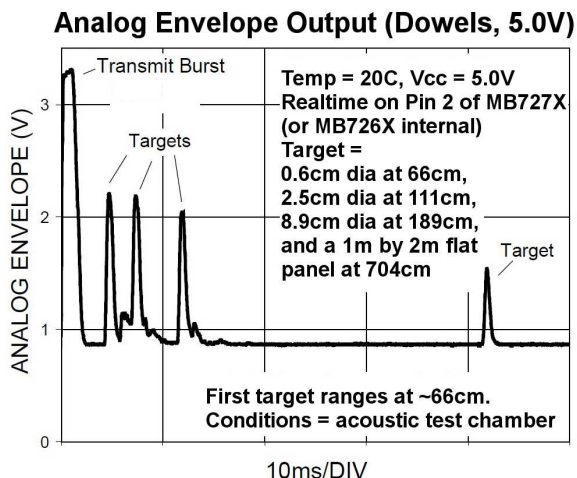
## Range "0" Location Continued



**The range is measured from the front of the transducer to the target.**

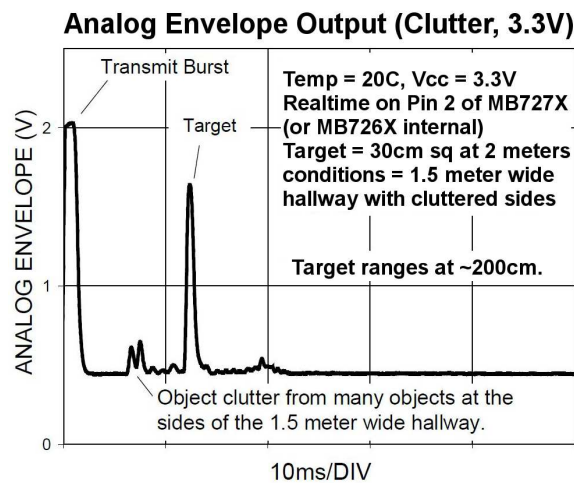
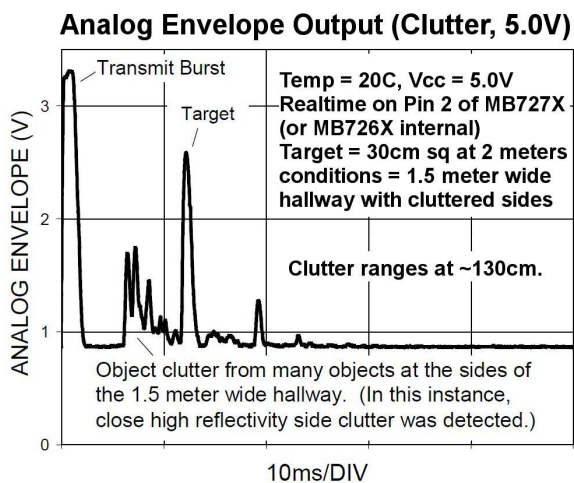
## Typical Performance to Target

All sensor models



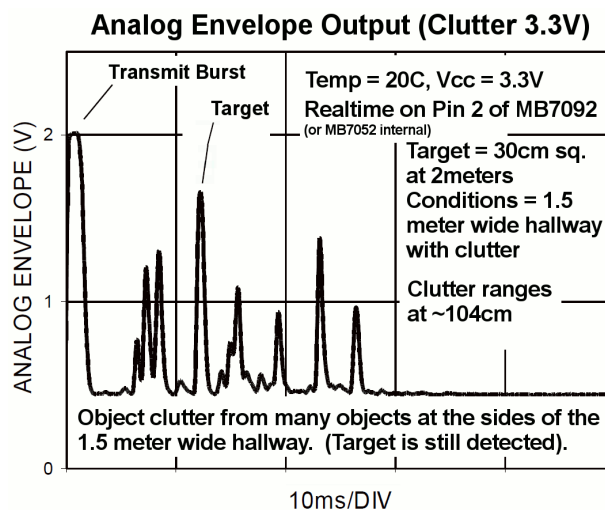
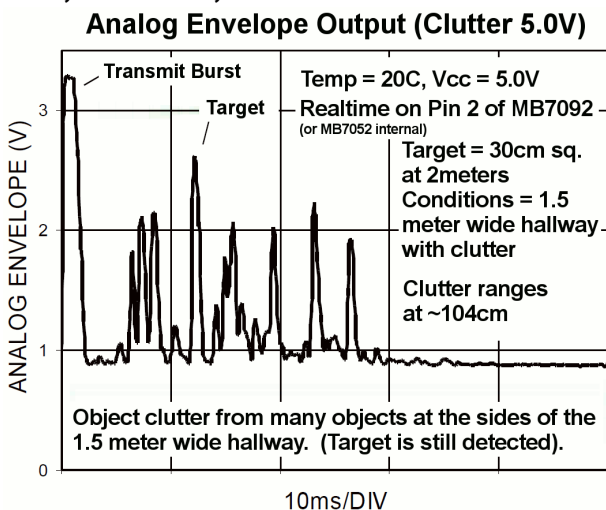
## Typical Performance in Clutter

MB7060, MB7062, MB7076, MB7070, MB7072, MB7076



## Typical Performance in Clutter

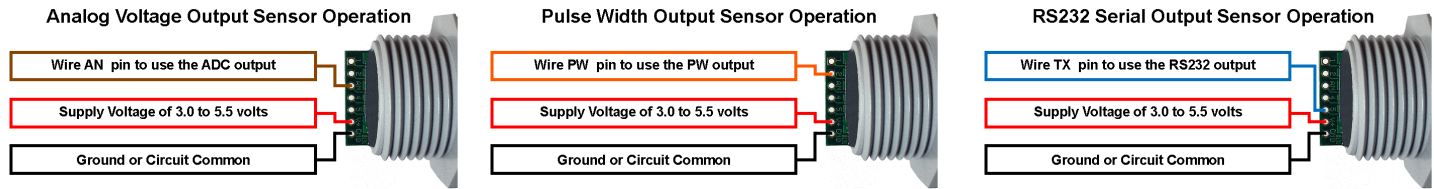
MB7051, MB7052, MB7092



## XL-MaxSonar-WR Sensor Operating Modes

### Independent Sensor Operation

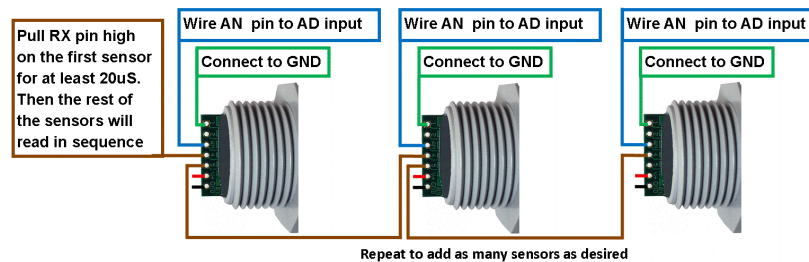
The XL-MaxSonar-WR sensors are designed to operate in a single sensor environment. Free-run is the default mode of operation for all of the MaxBotix Inc., sensors. The XL-MaxSonar-WR sensors have three separate outputs that update the range data simultaneously: Analog Voltage, Pulse Width<sup>1</sup>, and RS232 Serial. Below are diagrams on how to connect the sensor for each of the three outputs. Note 1 - select models output an Analog Envelope for end user processing (MB707X sensors and MB7092)



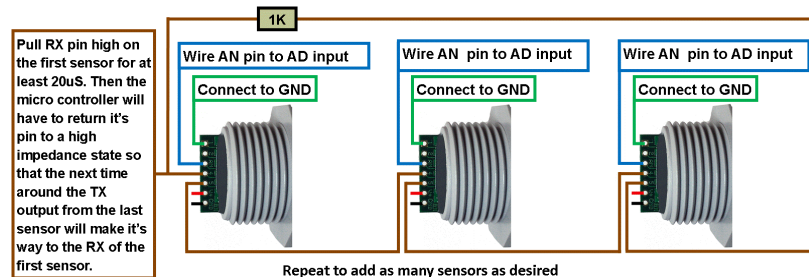
### Using Multiple Sensors in a Single System

When using multiple ultrasonic sensors in a single system, there can be interference (cross-talk) from the other sensors. MaxBotix Inc., has engineered a solution to this problem for the XL-MaxSonar-WR sensors. The solution is referred to as chaining. We have 3 methods of chaining that work well to avoid the issue of cross-talk.

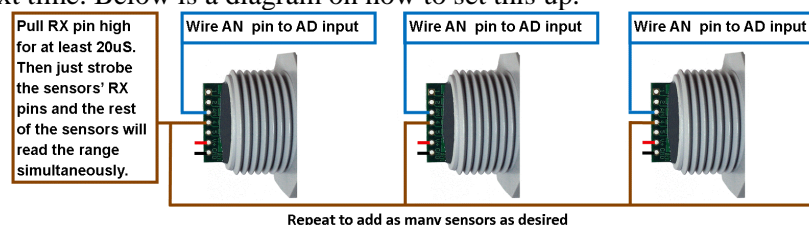
The first method is AN Output Commanded Loop. The first sensor will range, then trigger the next sensor to range and so on for all the sensors in the array. Once the last sensor has ranged, the array stops until the first sensor is triggered to range again. Below is a diagram on how to set this up.



The next method is AN Output Constantly Looping. The first sensor will range, then trigger the next sensor to range and so on for all the sensor in the array. Once the last sensor has ranged, it will trigger the first sensor in the array to range again and will continue this loop indefinitely. Below is a diagram on how to set this up.

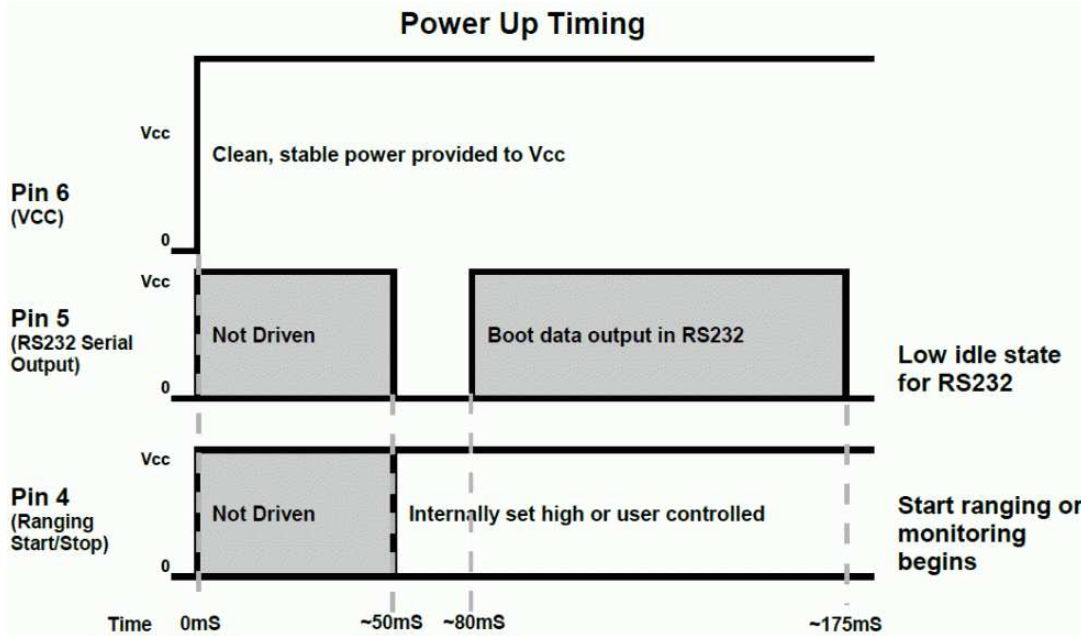


The final method is AN Output Simultaneous Operation. This method does not work in all applications and is sensitive to how the other sensors in the array are physically positioned in comparison to each other. Testing is recommend to verify this method will work for your application. All the sensors RX pins are connected together and triggered at the same time causing all the sensor to take a range reading at the same time. Once the range reading is complete, the sensors stop ranging until triggered next time. Below is a diagram on how to set this up.

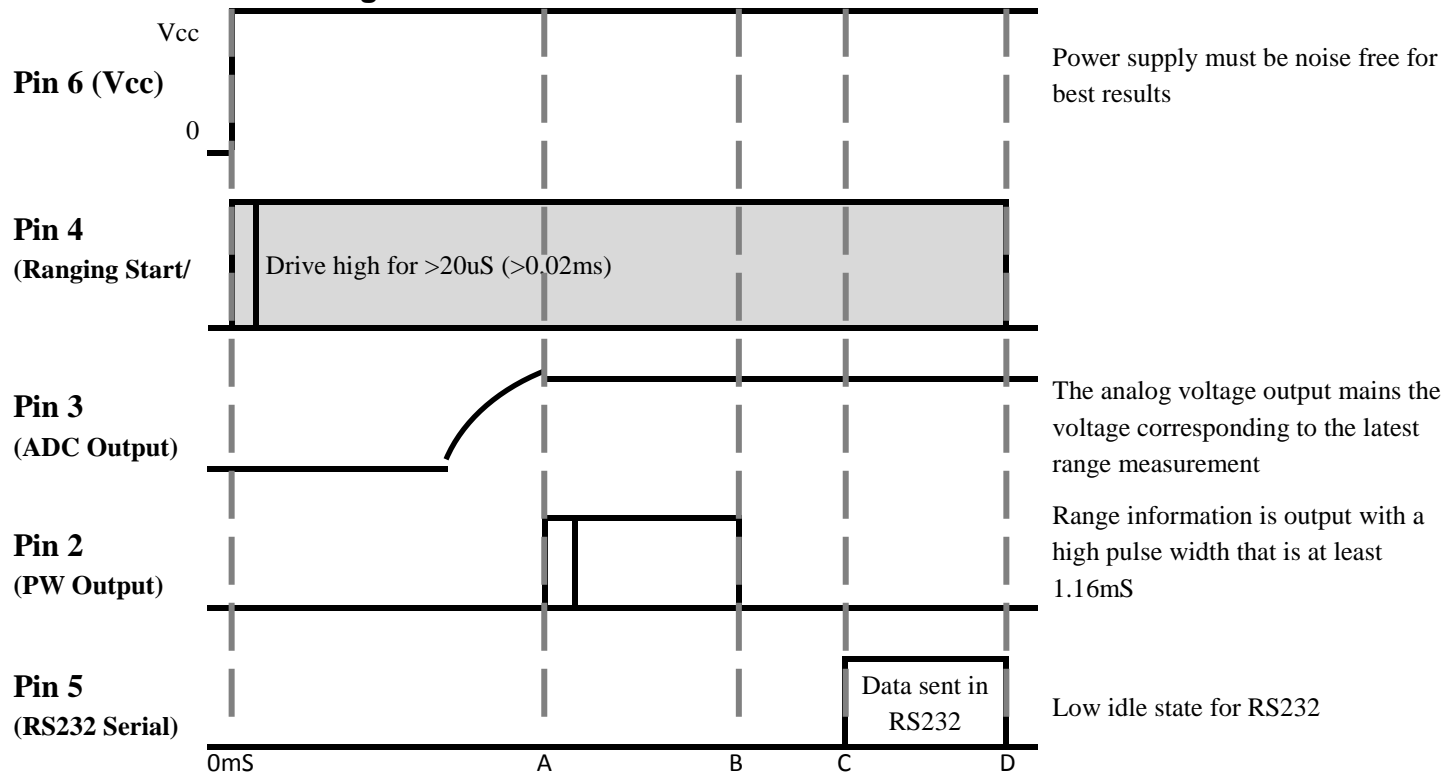


## Sensor Timing Diagrams

### Power-Up Timing



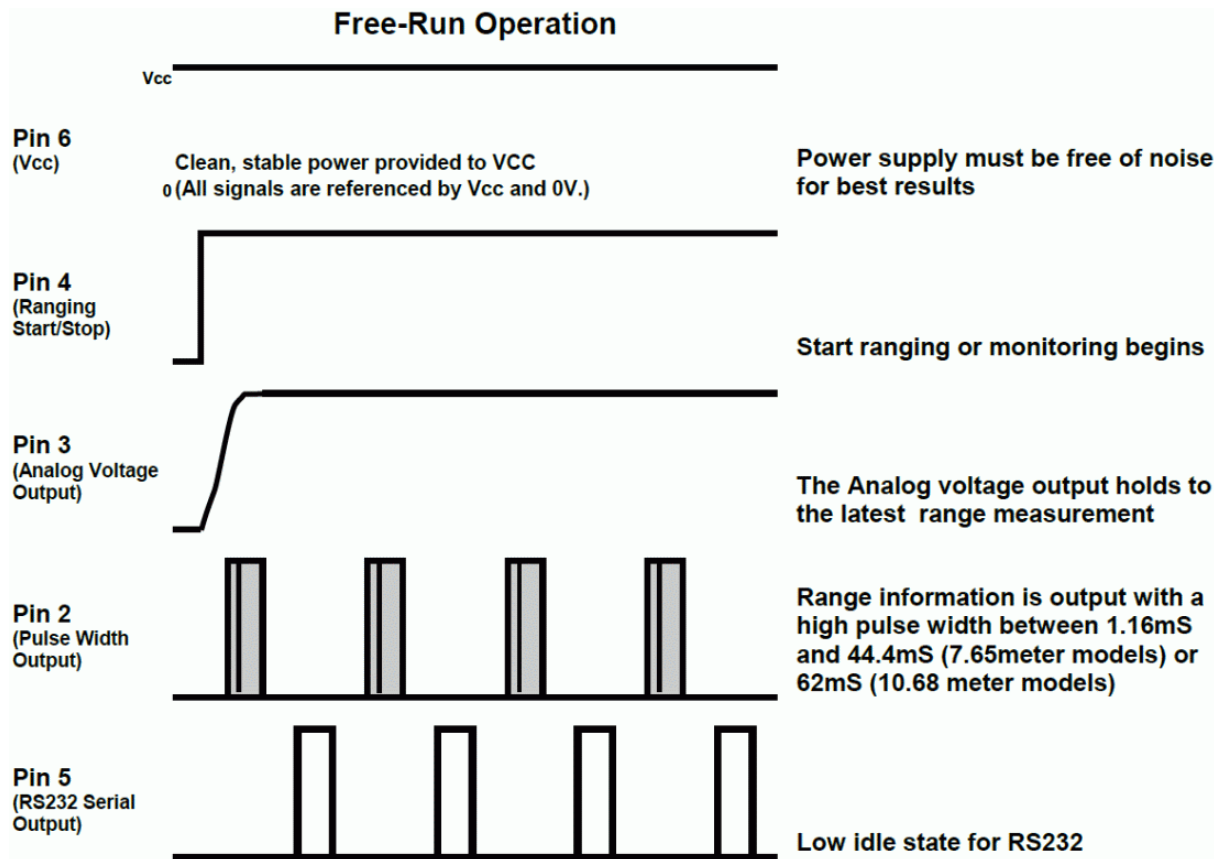
### Sensor Free-Run Timing



Product	Maximum Refresh Rate	Pulse Width Reported	Max Pulse Width End	Serial Data Reported	End of Range Cycle
MB7051	5.1Hz	~135mS	~195.9mS	~124mS	~196mS
MB7052	6.6 Hz	~82.3mS	~126.7mS	~144.3mS	~149mS
MB7060, MB7062, MB7066	10 Hz	~32.3mS	~76.7mS	~94.3mS	~99mS
MB7070, MB7072, MB7076, MB7092	10Hz	NA	NA	~94.3mS	~99mS

## Sensor Timing Diagrams Continued

### Real-Time Operation



### Timing Description

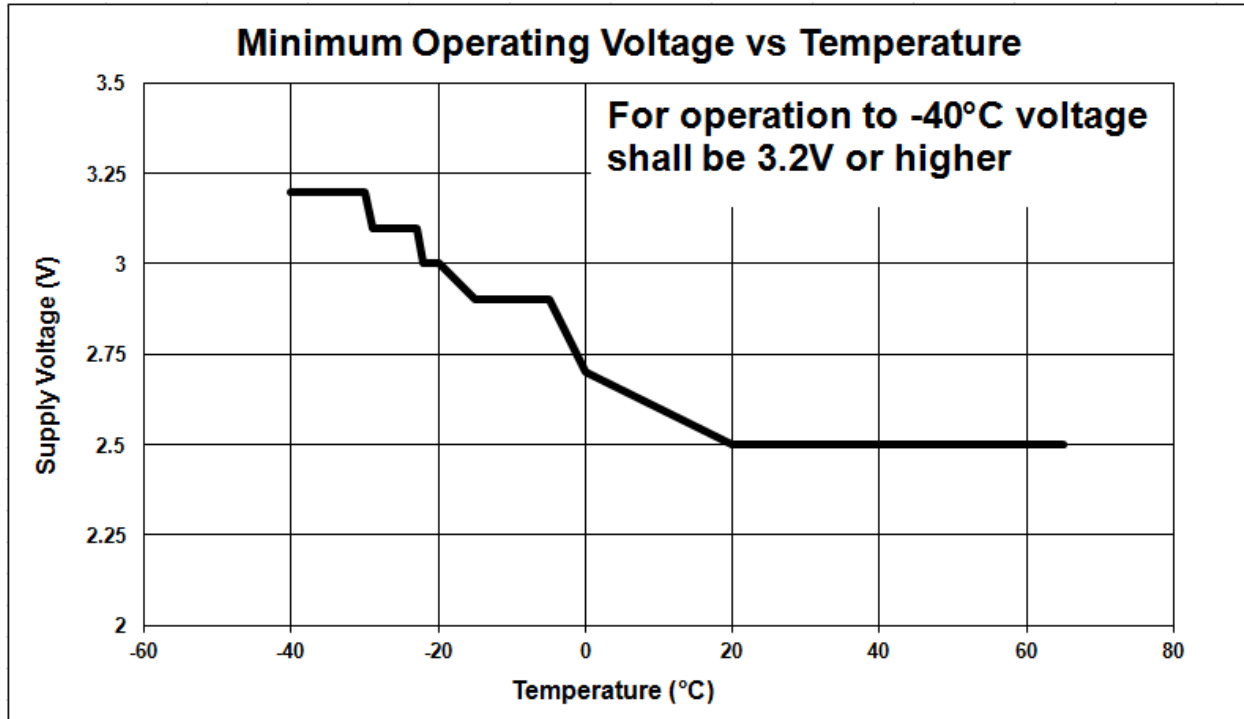
175mS after power-up, the XL-MaxSonar-WR is ready to begin ranging. If Pin-4 is left open or held high (20uS or greater), the sensor will take a range reading. The XL-MaxSonar-WR checks Pin-4 at the end of every cycle. Range data can be acquired once every period. Each period starts by Pin-4 being high or open, after which the XL-MaxSonar-WR calibrates and calculates for 20.5mS, and after which, the 42KHz waves are sent. The sensor then determines the range to the target. Next the analog voltage is set. The sensors with a pulse width (PW), Pin 2 is set high for a length of time<sup>1</sup>. Then serial data is sent<sup>1</sup>. The most accurate range output on the XL-MaxSonar-WR sensors is the PW output.

Note 1: Reference the timing specifications on the previous page for the exact times.

Sensors with the analog envelope output (MB7070 series and MB7092), Pin-2 will show the real-time signal return information of the Analog Waveform.

## Voltage vs Temperature

The graph below shows minimum operating voltage of the sensor verses temperature.



## Background Information Regarding our Beam Patterns

Each XL-MaxSonar-WR sensor has an individually calibrated beam pattern, and is matched to provide the approximate detection pattern shown in this datasheet. This allows end users to select the part number that matches their given sensing application. Each part number has a consistent field of detection so additional units of the same part number will have similar beam patterns. The beam plots are provided to help identify an estimated detection zone for an application based on the acoustic properties of a target versus the plotted beam patterns.

Each beam pattern is a 2D representation of the detection area of the sensor. The beam pattern is actually shaped like a 3D cone (having the same detection pattern both vertically and horizontally). Detection patterns for dowels are used to show the beam pattern of each sensor. Dowels are long cylindrical targets of a given diameter. The dowels provide consistent target detection characteristics for a given size target which allows easy comparison of one MaxSonar sensor to another MaxSonar sensor.

For each part number, the four patterns (A, B, C, and D) represent the detection zone for a given target size. Each beam pattern shown is determined by the sensor's part number and target size.

The actual beam angle changes over the full range. Use the beam pattern for a specific target at any given distance to calculate the beam angle for that target at the specific distance. Generally, smaller targets are detected over a narrower beam angle and a shorter distance. Larger targets are detected over a wider beam angle and a longer range.

### People Sensing:

For users that desire to detect people, the detection area to the 1-inch diameter dowel, in general, represents the area that the sensor will reliably detect people.

## MB7051 XL-MaxSonar®-WRML1™ Beam Pattern and Uses

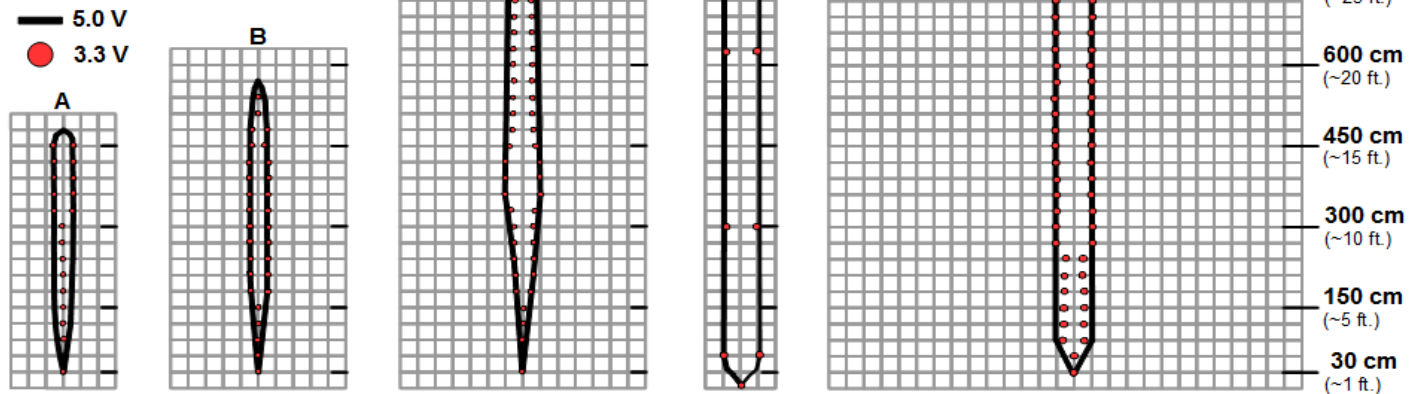
The XL-MaxSonar-WRML1 provides a super sensitive robust long range sensing solution. The MB7051 is ideal for applications requiring small or soft target detection ranges out to 10 meters. The sensor is great for applications such as people detection, 10 meter bin and tank level measurement, and soft target detection.

### MB7051-8XX

#### XL-MaxSonar® -WRML1™ Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for various targets. Targets are placed in front of the sensor. The target shapes shown below are not drawn to scale.

- A 6.1-mm (0.25-inch) diameter dowel 4ft length
- B 2.54-cm (1-inch) diameter dowel 4ft length
- C 8.89-cm (3.5-inch) diameter dowel 4ft length
- D 11-inch wide board 4ft in length moved left to right with the board parallel to the front sensor face. This shows the sensor's range capability.
- E 2" x 2" corner reflector 4ft long.



Beam Characteristics are Approximate

Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.

### MB7051 Features and Benefits

- Pencil beam applications >10°
- Super high sensitivity to small and soft targets. About 2.5 times further compared to the MB7052.
- Extremely narrow beam which is great for cluttered environments.
- 10 meter maximum distance.
- Clutter rejection provides range to the largest amplitude reflection within the field of view
- Real-time calibration, noise rejection and additional filtering

provides stable range information

- Excellent for ranging to large objects in the presence of cluttered or noisy environments
- Excellent for applications that require consistently accurate outputs
- Impressive acoustic and electrical noise resistance
- 5.1Hz refresh rate

### MB7051 Applications and Uses

- Pencil beam applications >10°
- Environments with acoustic and electrical noise
- People Detection
- Soft Targets
- Bin Level Measurement
- Tank Level Measurement

## MB7052-MB7092 XL-MaxSonar®-WRM1/WRMA1™ Beam Pattern and Uses

The XL-MaxSonar-WRM1/WRMA1 ignores smaller targets and only reports the range to the largest acoustic return. The filtering in the MB7052 and MB7092 also rejects moving target clutter such as rain or snow, electrical noise, and outside acoustic noise.

# MB7052-1XX MB7092-1XX

## XL-MaxSonar®-WRM1/WRMA1™ Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

A 6.1-mm (0.25-inch) diameter dowel

B 2.54-cm (1-inch) diameter dowel

C 8.89-cm (3.5-inch) diameter dowel

D 11-inch wide board moved left to right with the board parallel to the front sensor face.

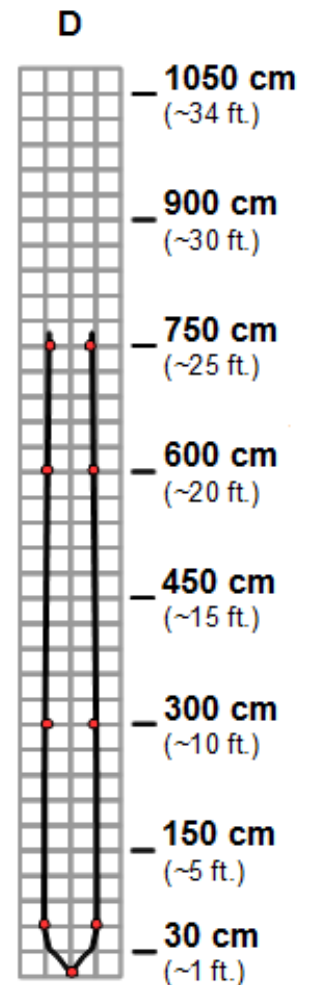
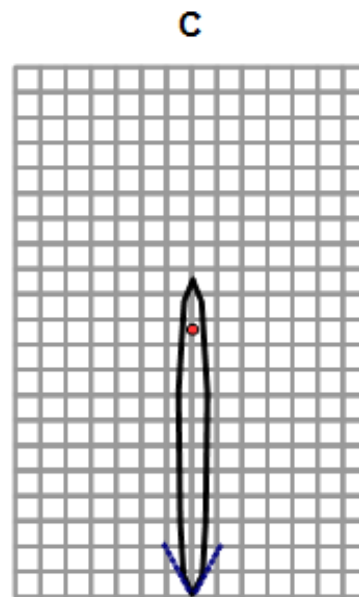
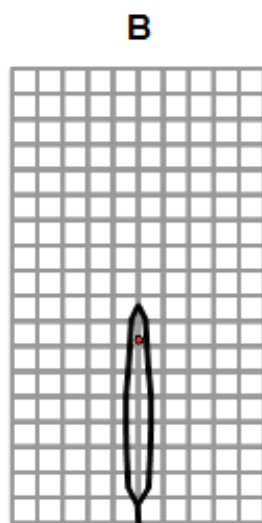
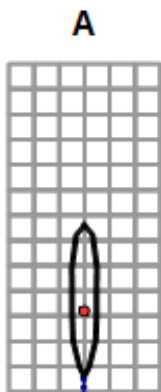
This shows the sensor's range capability.

**Note:** For people detection the pattern typically falls between charts A and B.

■ Partial Detection

— 5.0 V

● 3.3 V



**Beam Characteristics are Approximate**

Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.

### MB7052-MB7092

#### Features and Benefits

- Clutter rejection provides range to the largest amplitude reflection within the field of view
- Real-time calibration, noise rejection and additional filtering provides stable range information
- Excellent for ranging to large objects in the presence of cluttered or noisy environments
- Excellent for applications that require consistently accurate outputs

- Impressive acoustic and electrical noise resistance
- 10Hz refresh rate for the MB7092
- 6.6Hz refresh rate on the MB7052

### MB7052-MB7092

#### Applications and Uses

- Autonomous Navigation
- Environments with acoustic and electrical noise
- Bin Level Measurement
- Tank Level Measurement



## MB7060-MB7070 XL-MaxSonar®-WR/WRA1™ Beam Pattern and Uses

The XL-MaxSonar-WR/WRA1 reports the range to the first detectable target. The MB7060 and MB7070 sensors are the most recommended XL-MaxSonar-WR sensor. This is a good starting place when unsure of which XL-MaxSonar-WR to use.

# MB7060-1XX MB7070-1XX

## XL-MaxSonar®-WR/WRA1™ Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

- A 6.1-mm (0.25-inch) diameter dowel
- B 2.54-cm (1-inch) diameter dowel
- C 8.89-cm (3.5-inch) diameter dowel

D 11-inch wide board moved left to right with the board parallel to the front sensor face.

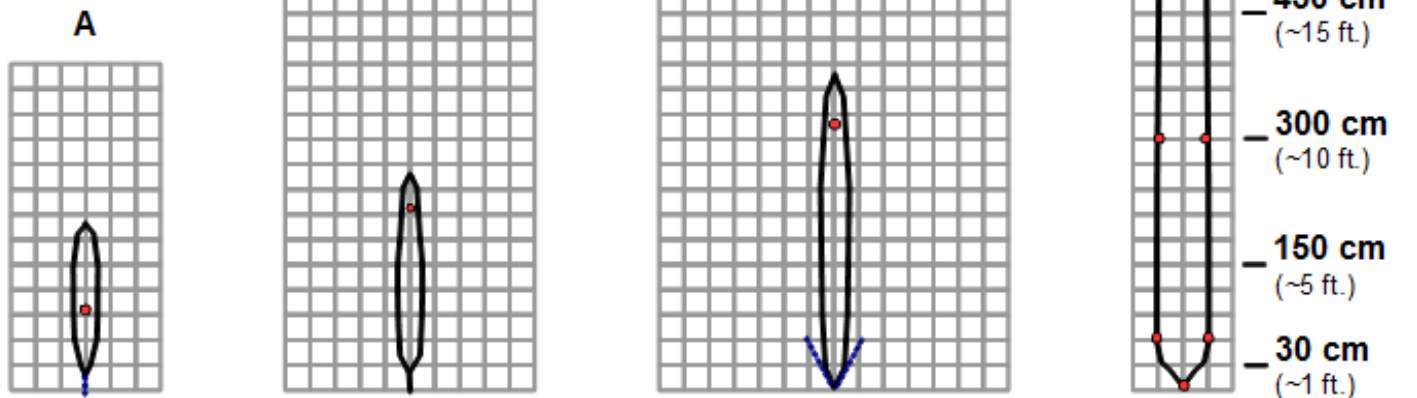
This shows the sensor's range capability.

**Note:** For people detection the pattern typically falls between charts A and B.

■ Partial Detection

— 5.0 V

● 3.3 V



**Beam Characteristics are Approximate**

Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.

### MB7060-MB7070

#### Features and Benefits

- Real-time calibration, and noise rejection for every ranging cycle
- Readings can occur up to every 100mS (10Hz)
- Analog voltage ( $V_{cc}/1024$ ) / cm
- Precise narrow beam
- Continuously variable gain

### MB7060-MB7070

#### Applications and Uses

- Applications where a stability filter is not needed or desired
- Multi-Sensor Arrays
- Distance Measuring
- People Detection

## MB7062-MB7072 XL-MaxSonar®-WR/WRA™ Beam Pattern and Uses

The XL-MaxSonar-WR/WRA sensors have a 3 reading stability filter in the firmware. This sensor is well suited for applications requiring stable, accurate range readings. This sensor ranges to the first detectable target.

# MB7062-1XX MB7072-1XX

## XL-MaxSonar®-WR™ Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

A 6.1-mm (0.25-inch) diameter dowel

B 2.54-cm (1-inch) diameter dowel

C 8.89-cm (3.5-inch) diameter dowel

D 11-inch wide board moved left to right with the board parallel to the front sensor face.

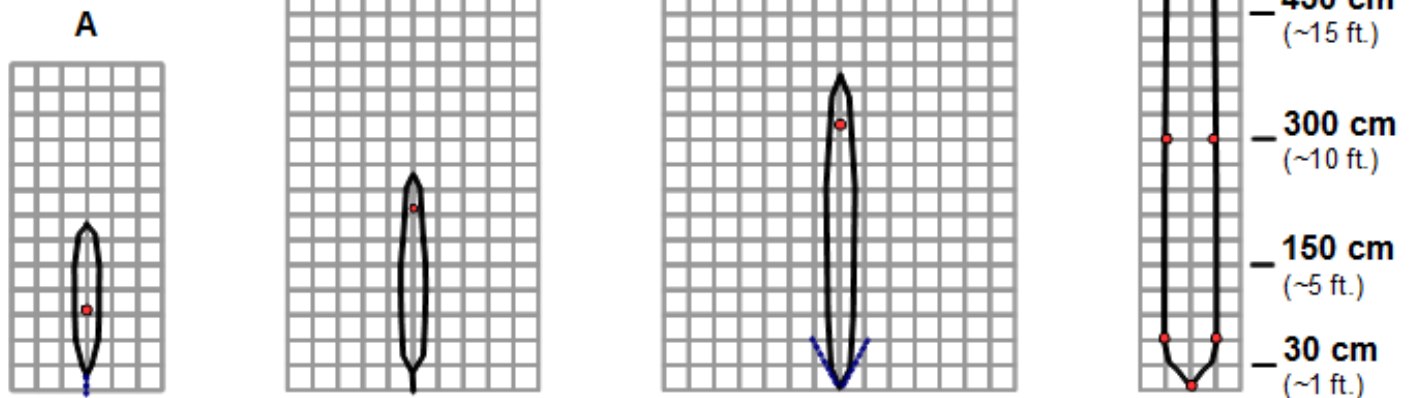
This shows the sensor's range capability.

**Note:** For people detection the pattern typically falls between charts A and B.

■ Partial Detection

— 5.0 V

● 3.3 V



**Beam Characteristics are Approximate**

Beam Patterns drawn to a 1:95 scale for easy comparison to our other products.

### MB7062-MB7072

#### Features and Benefits

- 1 hour fail-safe built into sensor
- Real-time calibration, noise rejection and additional filtering provides stable range information
- Excellent for ranging to large objects in the presence of cluttered or noisy environments
- Excellent for applications that require consistently accurate outputs
- Advanced acoustic and electrical noise filtered output

- Reports filtered output on serial and analog-voltage outputs
- Reliable stable range data
- No power up calibration is required

### MB7062-MB7072

#### Applications and Uses

- Long range object detection
- Industrial sensor
- Drop in upgrade for MB7060 and MB7070

## MB7066-MB7076 XL-MaxSonar®-WRL/WRLA1™ Beam Pattern and Uses

The XL-MaxSonar-WRL/WRLA1 ranges objects from 0-cm to 1068-cm (35 feet) and provides range information from 20-cm to 1068-cm with a 1-cm resolution. This sensor is designed for applications where large object detection is needed to 10 meters.

# MB7066-1XX MB7076-1XX

## XL-MaxSonar®-WRL/WRLA1 Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

A 6.1-mm (0.25-inch) diameter dowel

B 2.54-cm (1-inch) diameter dowel

C 8.89-cm (3.5-inch) diameter dowel

D 11-inch wide board moved left to right with the board parallel to the front sensor face.

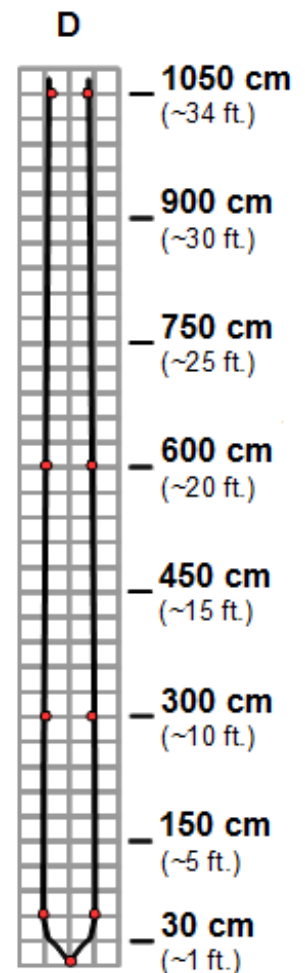
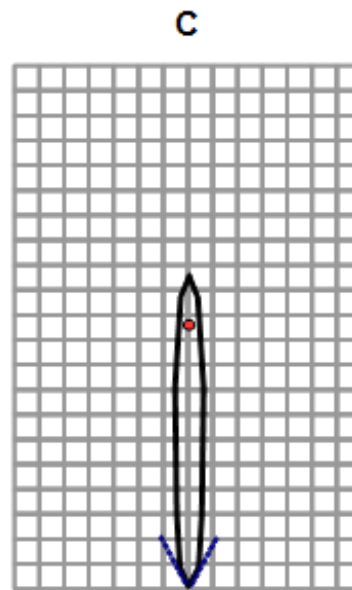
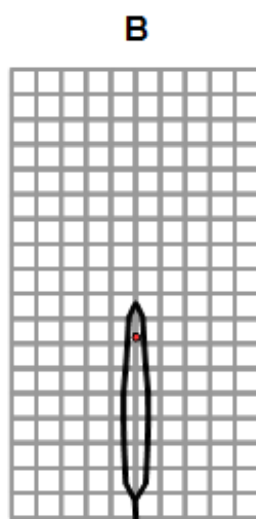
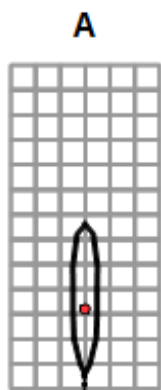
This shows the sensor's range capability.

**Note:** For people detection the pattern typically falls between charts A and B.

■ Partial Detection

— 5.0 V

● 3.3 V



**Beam Characteristics are Approximate**

Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.

### MB7066-MB7076

#### Features and Benefits

- Extended 10 meter range detection and outputs
- High acoustic power output
- Readings can occur up to every 100ms, 10-Hz rate
- Triggered operation provides the range reading as desired
- Fast measurement cycle
- Quality narrow beam characteristics
- Low cost, long range IP67 sensor

### MB7066-MB7076

#### Applications and Uses

- Robot ranging sensor
- Autonomous navigation
- Distance measuring
- Long range object detection
- Industrial sensor

## MB706X-MB707X XL-MaxSonar-WRC Beam Pattern and Uses

The XL-MaxSonar-WR product line is available in alternative housings that include a WRC housing, 1" NPS pipe threading, 1" BSPP pipe threading, and 30mm 1.5 pipe threading

MB7052-2XX MB7060-2XX MB7068-2XX MB7070-2XX MB7078-2XX MB7092-2XX  
 MB7052-5XX MB7060-5XX MB7068-5XX MB7070-5XX MB7078-5XX MB7092-5XX  
 MB7052-6XX MB7060-6XX MB7068-6XX MB7070-6XX MB7078-6XX MB7092-6XX  
 MB7052-7XX MB7060-7XX MB7068-7XX MB7070-7XX MB7078-7XX MB7092-7XX

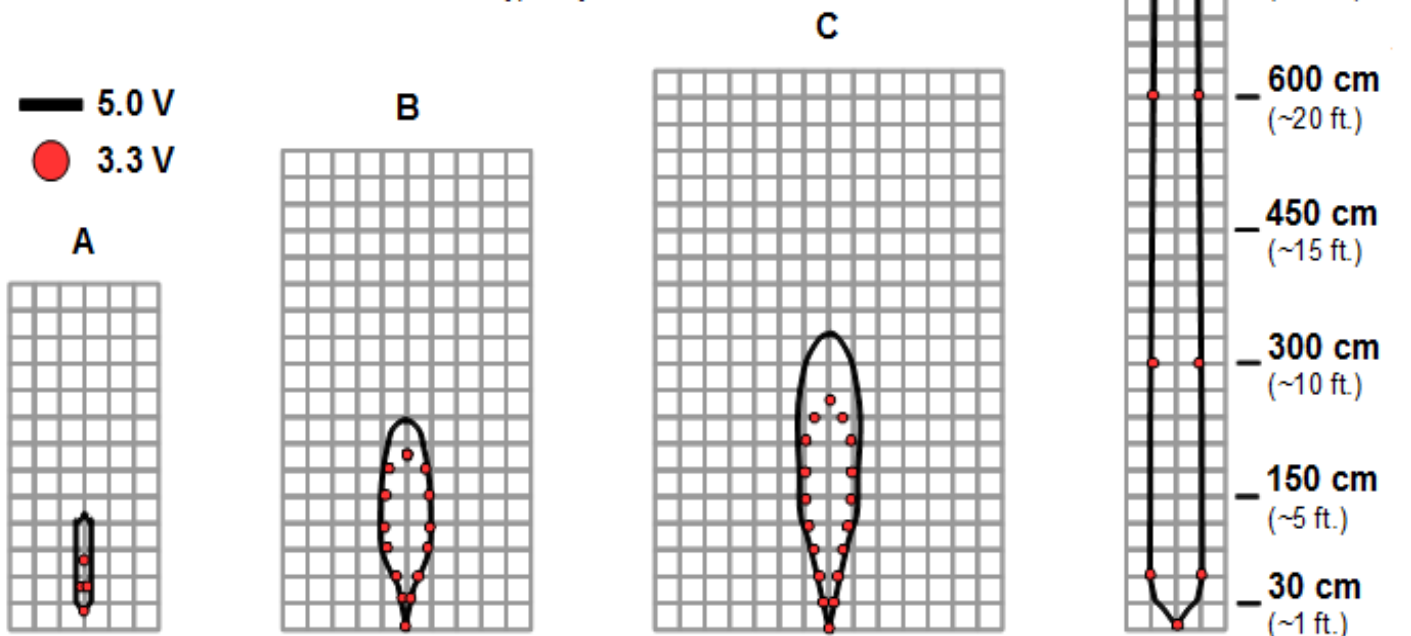
### XL-MaxSonar®- Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

- A 6.1-mm (0.25-inch) diameter dowel
- B 2.54-cm (1-inch) diameter dowel
- C 8.89-cm (3.5-inch) diameter dowel

D 11-inch wide board moved left to right with the board parallel to the front sensor face. This shows the sensor's range capability.

**Note:** For people detection the pattern typically falls between charts A and B.



**Beam Characteristics are Approximate**

Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.

### MB706X-MB707X

#### Features and Benefits

- Can be flush mounted in an application
- Same resolution as the full horn equivalent
- Available in both metric and imperial housing sizes

### MB706X-MB707X

#### Applications and Uses

- UAV blimps
- Bin level measurement
- Proximity zone detection
- Robot ranging sensor
- Tank level measurement
- Auto sizing

# MB706X-MB707X XL-MaxSonar-WR UltraCompact Beam Pattern and Uses

The XL-MaxSonar-WR product line is available in an UltraCompact alternative housing. The UltraCompact housing is designed for users that are creating a custom horn mount. The recommended horn can be downloaded from [http://www.maxbotix.com/Ultrasonic\\_Sensors/Outdoor\\_Sensors.htm](http://www.maxbotix.com/Ultrasonic_Sensors/Outdoor_Sensors.htm) under the “Documents” Tab.

- MB7052-300 MB7052-320 MB7070-300 MB7070-320 <sup>1</sup>
- MB7060-300 MB7060-320 MB7072-300 MB7072-320 <sup>1</sup>
- MB7062-300 MB7062-320 MB7092-300 MB7092-320 <sup>1</sup>

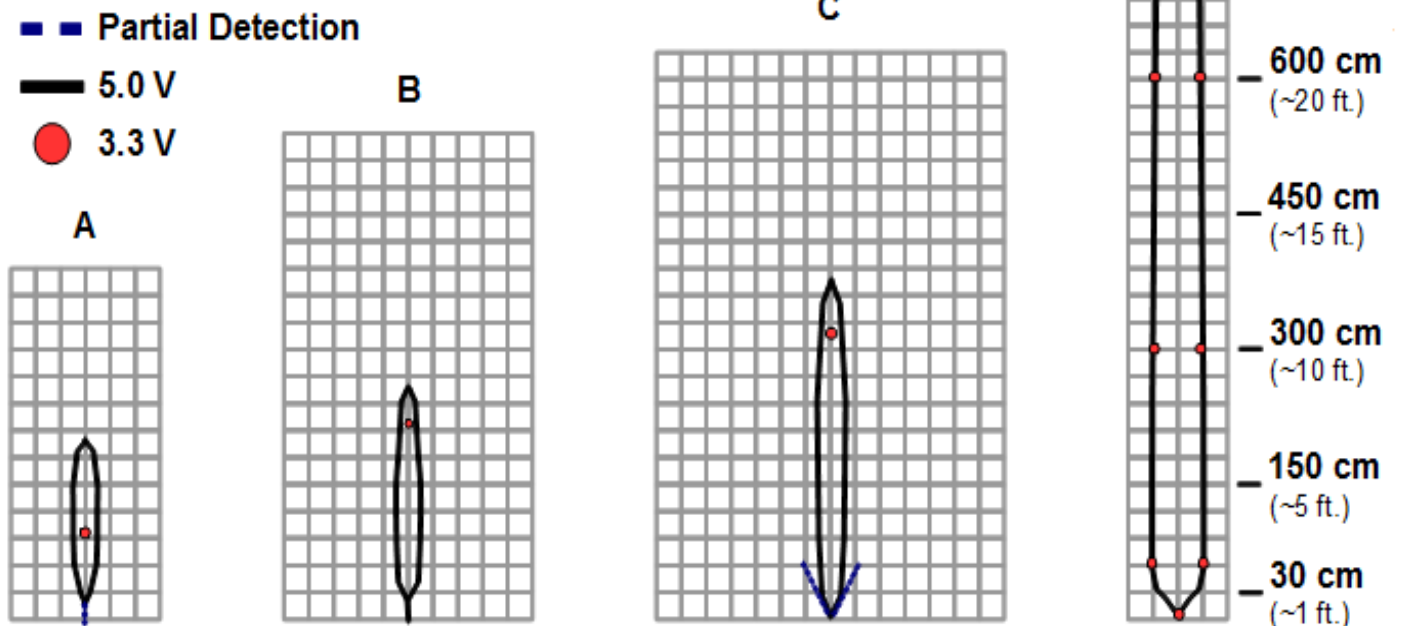
## XL-MaxSonar®- Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

A 6.1-mm (0.25-inch) diameter dowel  
 B 2.54-cm (1-inch) diameter dowel  
 C 8.89-cm (3.5-inch) diameter dowel

D 11-inch wide board moved left to right with the board parallel to the front sensor face. This shows the sensor's range capability.

**Note:** For people detection the pattern typically falls between charts A and B.



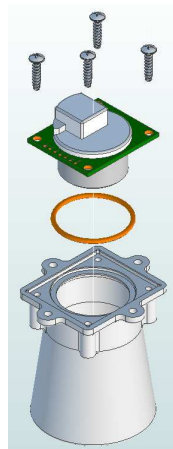
**Beam Characteristics are Approximate**

Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.

## MB706X-MB707X Features and Benefits

- Can be flush mounted in an application
- Same resolution as the full horn equivalent
- Gives the ability to create custom mounts

- Note 1: The “full horn” reference means that the sensor is mounted in a horn like the image to the right.



## MB706X-MB707X Applications and Uses

- UAV blimps
- Bin level measurement
- Proximity zone detection
- Robot ranging sensor
- Tank level measurement
- Auto sizing

# MB706X-MB707X XL-MaxSonar-WR UltraCompact Beam Pattern and Uses

The XL-MaxSonar-WR product line is available in an UltraCompact alternative housing. The UltraCompact housing is designed for users that want to create a custom mount. The recommended designs can be downloaded from [http://www.maxbotix.com/Ultrasonic\\_Sensors/Outdoor\\_Sensors.htm](http://www.maxbotix.com/Ultrasonic_Sensors/Outdoor_Sensors.htm) under the "Documents" Tab.

- MB7052-400 MB7052-420 MB7070-400 MB7070-420 <sup>1</sup>
- MB7060-400 MB7060-420 MB7072-400 MB7072-420 <sup>1</sup>
- MB7062-400 MB7062-420 MB7092-400 MB7092-420 <sup>1</sup>

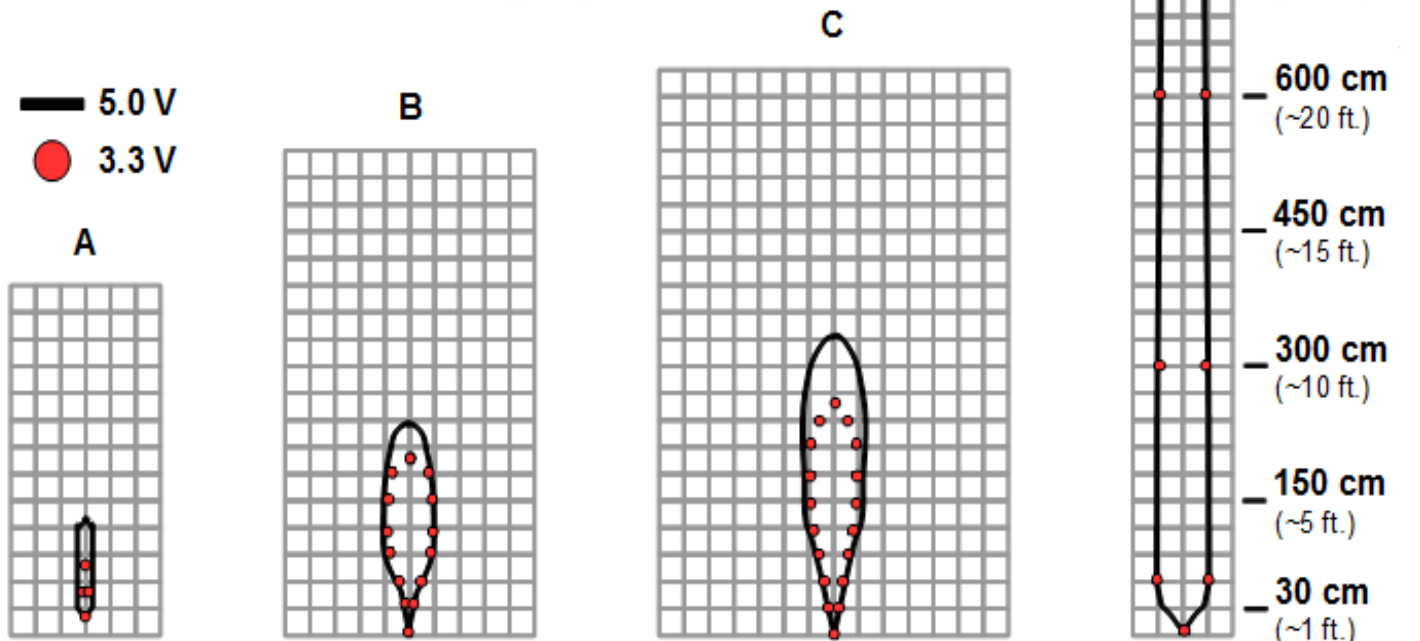
## XL-MaxSonar®- Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

- A 6.1-mm (0.25-inch) diameter dowel
- B 2.54-cm (1-inch) diameter dowel
- C 8.89-cm (3.5-inch) diameter dowel

D 11-inch wide board moved left to right with the board parallel to the front sensor face. This shows the sensor's range capability.

**Note:** For people detection the pattern typically falls between charts A and B.



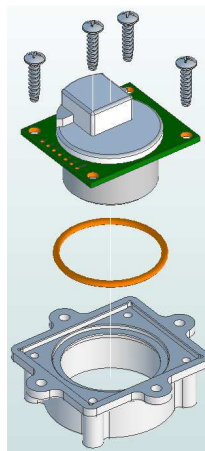
**Beam Characteristics are Approximate**

Beam Patterns drawn to a 1:95 scale for easy comparison to our other products.

## MB706X-MB707X Features and Benefits

- Can be flush mounted in an application
- Same resolution as the full horn equivalent
- Allows for custom mounts to be designed.

- Note 1: The "flush mount" reference means that the sensor is mounted in a housing without a horn like the image to the right or used without a housing.



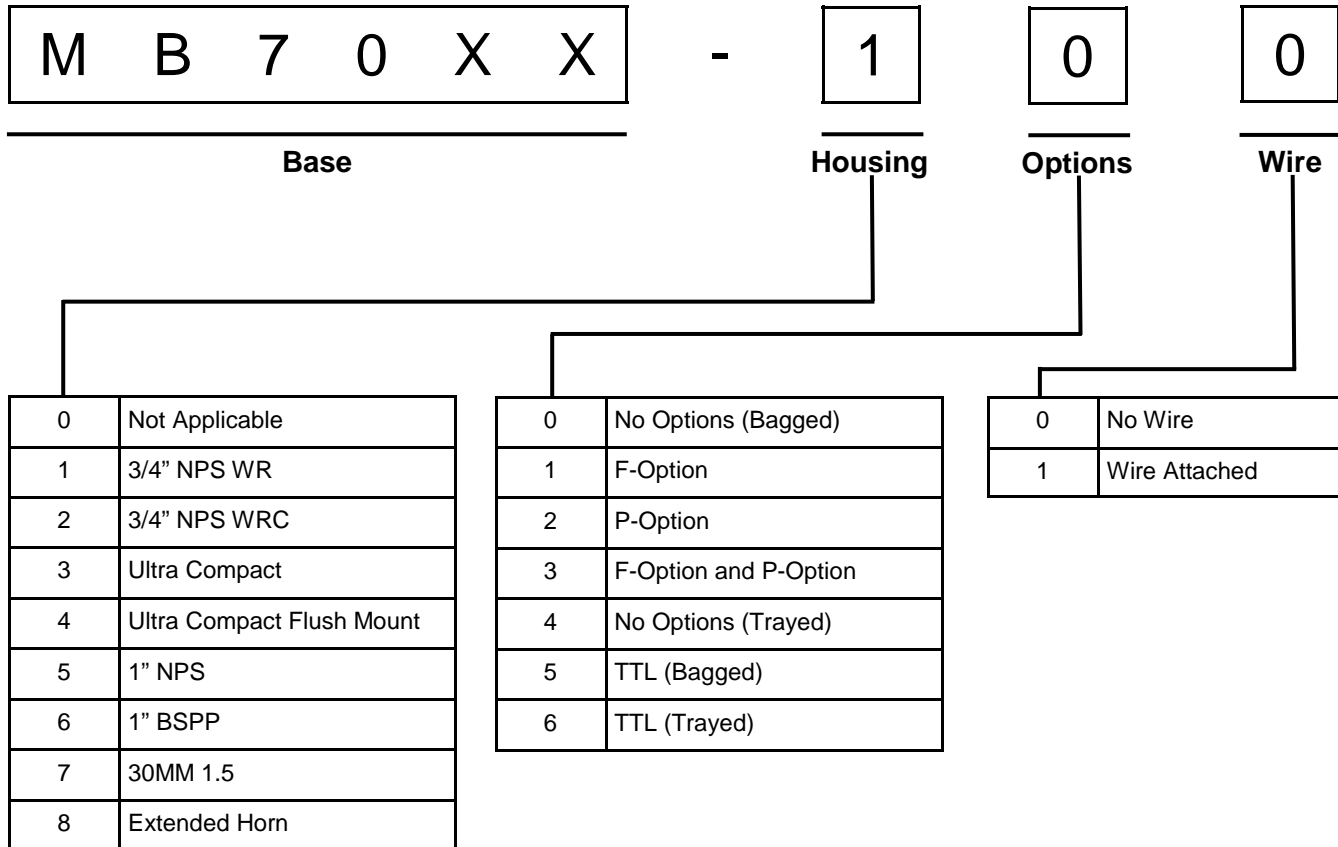
## MB706X-MB707X Applications and Uses

- UAV blimps
- Bin level measurement
- Proximity zone detection
- Robot ranging sensor
- Tank level measurement
- Auto sizing

## Part Numbers

All part numbers are a combination of a six-character base followed by a dash and a three-digit product code. Please review the following table for more information on the three-digit product code.

Note: Active part numbers listed on page 24 and 25.



The following tables display all of the active and valid part numbers for these products.

Active Part Numbers for MB7051							
MB7051-800	MB7051-801	MB7051-810	MB7051-811	MB7051-820	MB7051-821	MB7051-830	MB7051-831

Active Part Numbers for MB7052							
MB7052-100	MB7052-101	MB7052-110	MB7052-111	MB7052-120	MB7052-121	MB7052-130	MB7052-131
MB7052-200	MB7052-201	MB7052-210	MB7052-211	MB7052-220	MB7052-221	MB7052-230	MB7052-231
MB7052-300	MB7052-320	MB7052-400	MB7052-420	MB7052-500	MB7052-501	MB7052-510	MB7052-511
MB7052-520	MB7052-521	MB7052-530	MB7052-531	MB7052-600	MB7052-601	MB7052-610	MB7052-611
MB7052-620	MB7052-621	MB7052-630	MB7052-631	MB7052-700	MB7052-701	MB7052-710	MB7052-711
MB7052-720	MB7052-721	MB7052-730	MB7052-731				

The following tables display all of the active and valid part numbers for these products.

Active Part Numbers for MB7060							
MB7060-100	MB7060-101	MB7060-110	MB7060-111	MB7060-120	MB7060-121	MB7060-130	MB7060-131
MB7060-200	MB7060-201	MB7060-210	MB7060-211	MB7060-220	MB7060-221	MB7060-230	MB7060-231
MB7060-300	MB7060-320	MB7060-400	MB7060-420	MB7060-500	MB7060-501	MB7060-510	MB7060-511
MB7060-520	MB7060-521	MB7060-530	MB7060-531	MB7060-600	MB7060-601	MB7060-610	MB7060-611
MB7060-620	MB7060-621	MB7060-630	MB7060-631	MB7060-700	MB7060-701	MB7060-710	MB7060-711
MB7060-720	MB7060-721	MB7060-730	MB7060-731				

Active Part Numbers for MB7062							
MB7062-100	MB7062-101	MB7062-110	MB7062-111	MB7062-120	MB7062-121	MB7062-130	MB7062-131
MB7062-200	MB7062-201	MB7062-210	MB7062-211	MB7062-220	MB7062-221	MB7062-230	MB7062-231
MB7062-300	MB7062-320	MB7062-400	MB7062-420	MB7062-500	MB7062-501	MB7062-510	MB7062-511
MB7062-520	MB7062-521	MB7062-530	MB7062-531	MB7062-600	MB7062-601	MB7062-610	MB7062-611
MB7062-620	MB7062-621	MB7062-630	MB7062-631	MB7062-700	MB7062-701	MB7062-710	MB7062-711
MB7062-720	MB7062-721	MB7062-730	MB7062-731				

Active Part Numbers for MB7066							
MB7066-100	MB7066-101	MB7066-110	MB7066-111	MB7066-120	MB7066-121	MB7066-130	MB7066-131

Active Part Numbers for MB7070							
MB7070-100	MB7070-101	MB7070-110	MB7070-111	MB7070-120	MB7070-121	MB7070-130	MB7070-131
MB7070-200	MB7070-201	MB7070-210	MB7070-211	MB7070-220	MB7070-221	MB7070-230	MB7070-231
MB7070-300	MB7070-320	MB7070-400	MB7070-420	MB7070-500	MB7070-501	MB7070-510	MB7070-511
MB7070-520	MB7070-521	MB7070-530	MB7070-531	MB7070-600	MB7070-601	MB7070-610	MB7070-611
MB7070-620	MB7070-621	MB7070-630	MB7070-631	MB7070-700	MB7070-701	MB7070-710	MB7070-711
MB7070-720	MB7070-721	MB7070-730	MB7070-731				

Active Part Numbers for MB7072							
MB7072-100	MB7072-101	MB7072-110	MB7072-111	MB7072-120	MB7072-121	MB7072-130	MB7072-131
MB7072-200	MB7072-201	MB7072-210	MB7072-211	MB7072-220	MB7072-221	MB7072-230	MB7072-231
MB7072-300	MB7072-320	MB7072-400	MB7072-420	MB7072-500	MB7072-501	MB7072-510	MB7072-511
MB7072-520	MB7072-521	MB7072-530	MB7072-531	MB7072-600	MB7072-601	MB7072-610	MB7072-611
MB7072-620	MB7072-621	MB7072-630	MB7072-631	MB7072-700	MB7072-701	MB7072-710	MB7072-711
MB7072-720	MB7072-721	MB7072-730	MB7072-731				

Active Part Numbers for MB7076							
MB7076-100	MB7076-101	MB7076-110	MB7076-111	MB7076-120	MB7076-121	MB7076-130	MB7076-131



### Active Part Numbers for MB7092

MB7092-100	MB7092-101	MB7092-110	MB7092-111	MB7092-120	MB7092-121	MB7092-130	MB7092-131
MB7092-200	MB7092-201	MB7092-210	MB7092-211	MB7092-220	MB7092-221	MB7092-230	MB7092-231
MB7092-300	MB7092-320	MB7092-400	MB7092-420	MB7092-500	MB7092-501	MB7092-510	MB7092-511
MB7092-520	MB7092-521	MB7092-530	MB7092-531	MB7092-600	MB7092-601	MB7092-610	MB7092-611
MB7092-620	MB7092-621	MB7092-630	MB7092-631	MB7092-700	MB7092-701	MB7092-710	MB7092-711
MB7092-720	MB7092-721	MB7092-730	MB7092-731				

The legacy part numbers MB7067, MB7068, MB7260, MB7262, MB7267, MB7077, MB7078, MB7270, MB7277 and MB7278 are now contained within MB7060, MB7062, MB7070 and MB7072 which are the base for all housing options on these products. To select a product with a legacy part number, select the desired housing option on the product with the appropriate base. Please review the following table for more information.

IF YOU BOUGHT	NOW BUY	
Legacy Part Number	Base and Housing	Active Part Number
MB7067 – Compact	MB7060 in 3/4" NPS WRC Housing	MB7060-2XX
MB7260 – Ultra Compact	MB7060 in Ultra Compact	MB7060-3XX
MB7267 – Ultra Compact Flush Mount	MB7060 in Ultra Compact Flush Mount	MB7060-4XX
MB7067 – 1" NPS	MB7060 in 1" NPS Housing	MB7060-5XX
MB7067 – 1" BSPP	MB7060 in 1" BSPP Housing	MB7060-6XX
MB7067 – 30mm 1.5	MB7060 in 30mm 1.5 Housing	MB7060-7XX
MB7068 – Compact	MB7062 in 3/4" NPS WRC Housing	MB7062-2XX
MB7262 – Ultra Compact	MB7062 in Ultra Compact	MB7062-3XX
MB7068 – Ultra Compact Flush Mount	MB7062 in Ultra Compact Flush Mount	MB7062-4XX
MB7068 – 1" NPS	MB7062 in 1" NPS Housing	MB7062-5XX
MB7068 – 1" BSPP	MB7062 in 1" BSPP Housing	MB7062-6XX
MB7068 – 30mm 1.5	MB7062 in 30mm 1.5 Housing	MB7062-7XX
MB7077 – Compact	MB7070 in 3/4" NPS WRC Housing	MB7070-2XX
MB7270 – Ultra Compact	MB7070 in Ultra Compact	MB7070-3XX
MB7277 – Ultra Compact Flush Mount	MB7070 in Ultra Compact Flush Mount	MB7070-4XX
MB7077 – 1" NPS	MB7070 in 1" NPS Housing	MB7070-5XX
MB7077 – 1" BSPP	MB7070 in 1" BSPP Housing	MB7070-6XX
MB7077 – 30mm 1.5	MB7070 in 30mm 1.5 Housing	MB7070-7XX
MB7078 – Compact	MB7072 in 3/4" NPS WRC Housing	MB7072-2XX
MB7278 – Ultra Compact Flush Mount	MB7072 in Ultra Compact Flush Mount	MB7072-4XX
MB7078 – 1" NPS	MB7072 in 1" NPS Housing	MB7072-5XX
MB7078 – 1" BSPP	MB7072 in 1" BSPP Housing	MB7072-6XX
MB7078 – 30mm 1.5	MB7072 in 30mm 1.5 Housing	MB7072-7XX